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EDITORIAL

RESEARCH—AN AID TO PROGRESS*

A proof of how important research is getting to be in discovering and perfecting new methods lies in the fact that industry, no matter what its field or scale of production can no longer do without its staff of trained experts. Competition is becoming too keen to permit the least slackening of business alertness. Such world famous organizations as the Mellon Institute of Pittsburgh, the Bureau of Standards and Bureau of Mines at Washington, devoted wholly or in part to research, need no introduction. The staffs and equipment maintained for the same purpose by the General Electric and Westinghouse Companies—to mention only two among many—represent an enormous capital investment and loom large as budgetary items. The American Gas Association in the past five years has expended a sum of not less than one hundred thousand dollars annually in this all-important field.

The usefulness of the research specialist may be gaged by his activity in the field of industrial finishing. *Paints, lacquers* and varnishes are extremely difficult to handle and no single detail contributes more to salability or serviceability than an attractive and durable finish; its problems, however, are manifold, and require endless and thoughtful labor.

A national research organization is in a position to render untold service to the industry it represents. The oft repeated slogan of bygone days that "research is a gamble" and "research —gold brick, or gold bond" is giving way to a brand new trend which may be aptly summed up in the words, "every plant a laboratory."

*Industrial Gas.

NOTICE TO A. E. S. MEMBERS

If you are going to present a paper at our annual meeting in Washington, kindly boil it down to the FACTS you wish to illustrate for publishing. If necessary have two copies, one to read and one for publishing.

To all members and non-members who contemplate presenting papers to this annual meeting, notice is hereby given that in accord with our Constitution, Part I, Article X, Section 2, papers read before this Society become the property of the Society and can only be released to journals for reprinting 10 days after being published in our Review. This proviso can only be waived by full consent of the Executive Board.

It is hoped that our contributors will observe this rule and request. We fully appreciate the fact that in addressing a body, a lot of superfluities pop up in the impromptu introduction and add value to a lecture, but nothing to an article for publishing. And in past much confusion has come from desire of men reading papers, after it has received approval of A. E. S. in annual meeting, to spread through trade journals, and this is not ethical, according to our ideals.

EXPLANATION OF PLATS

Continued from J. Hay Article Published in May Issue of Review

Please change the part that reads "shows slides from 4 to 26" to read from one to six; and incorporate the new description in place of the old one.

Slide No. 1

Will illustrate the anodes as used in the tables given in the paper in regard to maintenance of the nickel solutions as in No. 1 and No. 4. Shows a nickel anode made by the Mond Nickel Company of the nickel oxide type—99+% pure. This anode was used in solution No. 1 and 2 as per table.

Slide No. 2

Slide No. 2 shows you a 99% plus type depolarized nickel anode. Note the rough structure of this anode. This anode was used in

the same solution as slide No. 1 or in other words in solution No. 1 and No. 2. We did not control the boric acid in either of these two solutions.

Slide No. 3

Shows a Mond nickel anode as used in solution table No. 3, with 5 ounces nickel chloride and boric acid control. Note the big improvement in the appearance of the anode. This also is a 99+% anode as in Slide No. 1.

Slide No. 4

Shows the depolarized 99+% nickel anode the same as Slide No. 1. Note the appearance of the anode. This anode has also been used in solution No. 3, as given per table on nickel solutions.

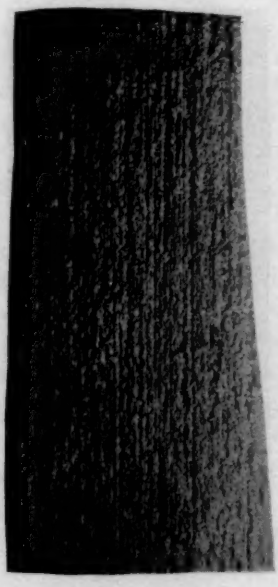
Slide No. 5

Will show you the same anode as in Slide No. 1 which was used in solution No. 4, as per table No. 4, with 11 ounces nickel chloride content and 4 ounces of boric acid.

Slide No. 6

Shows you the same nickel anode as Slide No. 2. This anode was also used in solution No. 4, with 11 ounces nickel chloride and 4 ounces boric acid.

Slide No. 1



Slide No. 2

Slide No. 3

Slide No. 4

Slide No. 5

Slide No. 6

ELECTROPLATING

By F. J. Liscomb

Read at Milwaukee Branch Annual Meeting

Electroplating is an art or process whereby a thin, adherent coating of metal can be laid on the surface of another metal by electro-chemical means. That is, with the aid of certain chemicals and a proper current of electricity, a heavy piece or anode of one metal can be gradually dissolved into a solution of chemicals, and is then, by the same current, removed from the chemical bath onto the surface of a cathode. The cathode may be composed of any metal provided its solution pressure is not so great that the cathode metal will spoil the bath by precipitating metal out of the solution and then itself entering the solution.

A simple illustration will suffice to make this point clear.

Let us consider a solution of copper sulphate in water, fitted with anodes. Here we will find that if we provide a cathode of brass with a suitable current density we may deposit on it copper that will be very adherent and of a fine color and texture. However, if we provide a cathode of iron or steel, our results are very different and are far from satisfactory because the iron or steel has a greater affinity for the chemicals of the solution; that is, it has greater solution pressure. Therefore the iron will enter the solution, and, although the copper will be precipitated onto the iron in chemical proportions, the precipitate or deposit will not be adherent because the iron under the copper has been dissolved. If the action is allowed to proceed, all of the copper will be thrown out of the solution and will be replaced by iron, so that finally we will have a solution of iron sulphate instead of copper sulphate. Therefore, as our job requires that this copper deposit be done in an acid bath, because of the beautiful grained surface obtained by this method, we must resort to some process whereby we can treat the iron cathode so that the iron will not come into contact with the acid copper solution. We can overcome our difficulty by plating the iron with copper in an alkali bath. This alkali bath will not affect iron as an acid copper bath will. Or, we may nickel plate the iron in a neutral bath, after which the acid copper bath may be used successfully. Zinc also exerts a

similar action in both acid and alkali copper baths. Zinc likewise enters a nickel solution.

Now that we have taken up briefly the process of electroplating, we ought to know why we electroplate. There are several reasons why we plate baser metals with a more noble metal. They are as follows:

1. To prevent corrosion or rust. Some metals do this better than others; namely, cadmium and zinc.
2. To obtain uniformity of color. For example, an article may be fabricated of several different metals, such as iron, brass, lead, etc., and, since there would be several different colors in the finished article, we plate all of the pieces in the article with a metal to give them a uniform color or finish.
3. To beautify a base metal; that is, to make it look like gold or silver or some other finish.
4. To aid in the local carbonizing of steel.
5. Dies and molds and printing plates.

If we disregard corrosion, beauty, and uniformity of color on a manufactured article, and consider the deposit only insofar as the usefulness of the article is concerned, then we need not plate, because a knife will cut no better after being plated, nor will an automobile pull any more freight after this process.

Probably the most extensive use for electroplating is to prevent corrosion or rust. We have learned by experience first, and later proved by science, that if one metal is coated with another there is less tendency for the base metal, steel, to rust or corrode. The question is, what metals should we plate and what metals should we deposit? If we plate steel with cadmium or zinc we prolong the life of the steel at the expense of the zinc or cadmium, as these are corroded instead of the steel, but they afford a great deal of protection because they do not corrode as rapidly as the steel. However, a thin coat of nickel on cast iron would offer little or no protection against corrosion, because, as the iron is porous, the nickel is deposited on a network of interstices, and is therefore not continuous. Thus, there is corrosion of the steel through the nickel. Furthermore, since the nickel is more positive than the iron under these conditions, nickel will actually hasten the corrosion. A light coat of copper on the iron would hasten corrosion even more than the nickel, because copper is more positive than nickel. Cadmium is the best metal for delaying corrosion, but cadmium is not a satisfactory metal to use

where a high-grade finish is desired and where beauty is the main requisite. Therefore, if we use a more electro-positive metal which because of its beauty has little or no rustproofing power, we must resort to a subterfuge and deposit several coatings of this metal, each one processed to remove nodules, etc., or buffed in an endeavor to close up any porous spots in the base metal. By this means we get a continuity of coating through which no moisture or corrosive liquids can penetrate. These several coatings, deposited one over the other, (NI. CU. NI.) must be of considerable thickness to accomplish a rustproofing job.

As cadmium gives the most continuous deposit, a thin deposit of this metal, .00025", affords considerable protection from corrosion. To get the same protection with zinc we would have to use four times this thickness.

Before we go farther, let us consider the preparation of work to be plated.

Articles to be plated must first be free from scale, grease or other dirt. The method of cleaning varies with the material, which may be:

Hot rolled steel (Heavy scale)—will not be more than mentioned as the treatment is usually done outside of the plating department.

Bright annealed steel.

Cold rolled steel.

Polished, cold rolled.

Cast iron.

If there is much mineral oil on the surface, it is often safer, as well as more economical, to put the article through a hot, soap-box bath to emulsify the oil and remove it. This is followed by a hot rinse. The article is next put into the electric cleaner tank. In this bath the article is made the cathode and a current of preferably 50 to 75 amperes per square foot is used. This current decomposes the water into its constituent gases; namely, oxygen at the anode and hydrogen at the cathode. There are two reasons for making the article the cathode: First, the gas given off is what is known as a reducing gas, that is, it reduces the oxide to metal; and second, there is twice as much hydrogen liberated as there is oxygen. Therefore, since the electric cleaning process is more of a mechanical action than a chemical action, it follows that with two volumes of gas there will be more mechanical action than if the article is cleaned on the anode.

Furthermore, if the article is cleaned on the anode or positive pole, great care must be taken to see that the free cyanide or free caustic content is high enough, for, if it is not, the polished steel will be oxidized instead of cleaned, if sulphates and chlorides of sodium or ammonium are present. The temperature of an electric cleaner solution should be approximately 160° F. If the temperature is higher than this the work dries out before the soap and cleaner can be washed away. The rinse following a cleaner should be warm, because warm water is better qualified to remove cleaner residue than cold water.

After steel has been processed through several cleaners and rinses, the surface becomes slightly oxidized due to the action of air and water. Often this hydroxide of iron accumulates on the surface of the steel in such quantities that it becomes necessary to remove it before placing the article in the plating tank. This is best done by the use of an acid dip which is composed of muriatic acid, usually 20 to 50 per cent acid. The article should then be thoroughly and quickly rinsed at least twice and put in the plating bath without delay. Although acid will do for both steel and brass, in the event that the article is brass a strong cyanide dip is preferable to the acid dip, but cyanide does not help so much on steel.

We are now ready to plate, and, although past experience has shown that the highest state of rustproofing is to be desired, yet, due to production cost and time, it has been found advisable to adopt an arbitrary figure for both the quantity or thickness of the deposit, and the quantity of current necessary to electroplate. It is generally acknowledged that 2/10,000 of an inch in thickness of deposit gives a fair protection. It so happens that 8 to 10 amperes per square foot will give us that thickness of deposit in about 20 minutes. These are simply average figures and may be increased or diminished. In cases where the deposit must be brighter, (less nickel) less current may be used, while, with a suitable solution, much more than 10 amperes per square foot may be successfully used if a heavier deposit, which will of course be less bright, is desired. The deposit can also be increased or diminished by changing the time factor of 20 minutes.

To summarize then:

We must determine what metal is to be plated, and what metal is to be deposited.

Condition of metal to be plated:

Scale, slight scale, cold rolled, oiled, ball burnished, etc.

From their condition determine what type of cleaning is necessary:

Gasoline, soap-soak, electric cleaner, copper cleaner, acid dips, etc.

Suitable rinse tanks.

It is assumed, then, that all of the above conditions have been met, and we now have the plant ready for operation.

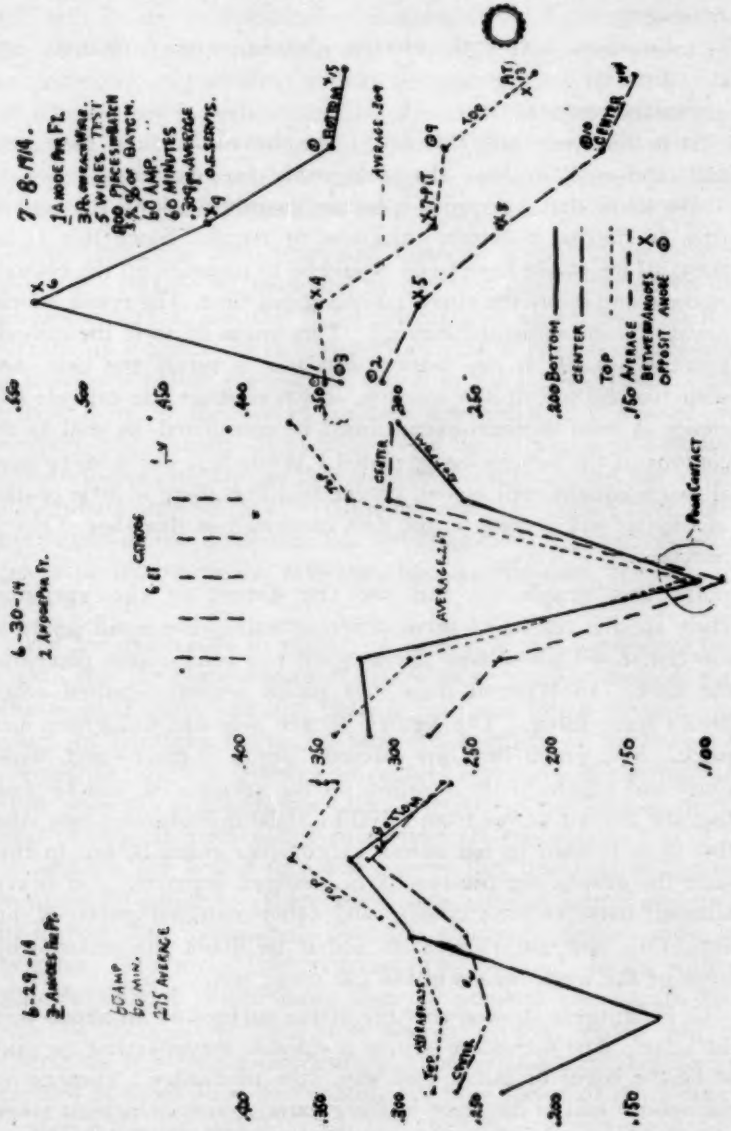
We know that it requires a certain current working for a given time to deposit a certain thickness of metal. Since this is so, then, all we would have to do would be to measure up the cathode surface and apply the current for a given time. The result should always be the same and correct. This might be so if the cathode surface was all in one plane. But this is rarely the case, and then too the pH of the solution, which controls the cathode efficiency at least to some extent, must be considered, as well as the contour of the articles being plated. While it is our wish to have all parts equally well plated, yet we find that there is little chance of this, as will be seen in the data contained in this slide. (No. 2 Servis).

By this graph we can see the extent of the variance. Here are the results of three different tests: The small figure at top center will show how the weighed test pieces were placed in the tank. In between these test pieces several hundred other pieces were hung. The figures on the side are milligrams per piece. The graph lines are labeled "Top," "Center" and "Bottom" and allude to the position on the spring. It will be seen that the deposit varies from .0100 to .0480 milligrams. Just why this is so is hard to tell unless we consider contacts, but in this slide the graphs are the results of soldered contacts. On heavy bumper bars, radiator shells, and other external parts of an auto, this same variance exists and is no doubt the reason why some of the work breaks in the salt spray test.

C. F. Burgess showed that the active surface of an anode was the edge. The active surface of a cathode may likewise be said to be the edge; or put it this way, "the near edge," (nearest to the anode) and is the place where greatest action or deposit takes place. Hence it is this "near edge" that we find rough deposits, (largest nodules) pits or porous and burned deposits.

Often we find many large plating tanks connected up in mul-

tiple without tank rheostats. This would not be so bad providing the same cathode, area, solution, temperature and solution resistivity were all alike.



Slides: Show two lots of nickel solution that were worked in multiple. The metal content of one lot indicates only partial chemical control.

Slide: Shows first a piece of ordinary tin plate. Nickel has been deposited on a similar sheet from three different prepared salts. Worked in series. Note the difference in the size of the grain or nodule. The composition of the salts is not known but directions were followed. All will buff satisfactorily, although one will be better than the other two.

Some pitting slide: Pitting is due to many causes, such as high current density, wrong pH, organic matter in solution, etc. They may all be to blame, but just why a solution will pit in only one area and not throughout the rest of the tank is a mystery.

Slide: We find that only the work on the bottom row of all the racks in the tank has all sorts of imperfections. Above this lower row of pieces the whole batch is free from pitting.

Slide: Shows a roughness, going crosswise of the usual lines, due to polishing. It is thought that this roughness might be due to the adherence of metal bearing dirt to the metal surface and that a deposit of nickel covered the dirt. Several nodules also appear.

Slide: Shows the lower edge of the piece of steel from which these last two micrographs were made. You will admit that there are some pits here, yet only a few pieces in this bath were so marked. The pH of the solution was 5.8. This may have been due to the stratified condition of the solution; i. e., different pH at the bottom of the tank. In other words, the solution had not been sufficiently or frequently stirred.

Stratification of the Solution: *Slide*: Here we see sodium chloride in water and ammonium chloride in water, each a separate cell, with a nickel anode in each cell connected in series. The cathode is a fine wire in a small glass tube which is open at both ends in order that it may act as a diaphragm, which allows a small current to pass without stirring the main solution. In the sodium chloride cell the anode goes into the solution momentarily, but is precipitated as nickel hydroxide by the NaOH which is liberated, but in the ammonium chloride solution the anode is dissolved. The solution dissolves the nickel and stratifies the nickel bearing solution which settles in the bottom of the cell. Seemingly the ammonium chloride is split up and the nickel and chlorine unite, the solution becoming green. The slide shows blue. The odor of the ammonia is noticeable. Eventually the nickel chloride strata rises into the zone of the ammonia. This upper strata becomes a deep blue color, showing that the metal

does go into the solution and stays there, while in the sodium chloride solution the metal is precipitated. None stays in the solution. If this reaction takes place in a plating solution one can understand why, in the presence of an excess of ammonium chloride, the metal content increased and consequently there is a difference in the pH figure towards 6 or higher. We can also understand why there is much nickel hydrate found in the sludge of mechanical plating barrels in which an excess of sodium chloride, high current densities, and small anode areas prevail. There is a speed limit but we seem to be exceeding it. Further evidence that solutions do become stratified can be seen in the slide.

Slide: Here we see the result of working a brass solution with a copper anode for many hours. Note that the lower edge of the cathode has a different color than the top. The bottom has an all-copper deposit. If this solution had been frequently stirred this difference would not exist.

Slide: Shows one cause of pits or holes in a nickel plated die casting. It has been found that when a tin-bearing die casting is heated by heavy buffing the tin will ooze out. This tin will be wiped away by the buff, leaving a small pin hole which the plating will not fill up or cover. This is often called a pit and perhaps it is, but the plating solution is not to blame for it. The same kind of a hole often appears on highly polished, cold rolled steel, when it is pickled in acid that is too strong.

Slide: Shows the results obtained when a proper current density is used in depositing a metal. In metallizing the flowers and lace the current was low and the deposit smooth.

Slide: There is a contrast here. Too much current was used by the plater, who wished to do in three hours what should have taken at least twenty-four hours.

Slide: While very little is actually known about pitting, there is a suspicion in the minds of some of us who have carried on many years that the generator and the manner of using it are often to blame. The next two slides will in a measure explain this. First we see an early Weston generator which is over fifty years old, having been built in the year 1876. It is a series wound machine. Note the centrifugal mercury field shunt used to prevent a reversal of a field polarity in the event of a sudden stoppage while the plating load was on. The voltage of this machine is 3 to 5, but the amperage is still a problem.

Slide: The next slide shows a recent interpole generator of 6

volts and 10,000 ampere capacity. One does not necessarily have to draw very heavily of his imagination to believe that the early generator, at about half the voltage of the larger machine, could hardly cause much of a pit in a deposit required several hours to make, and which was only .0001" in thickness, while with a larger machine it is possible to lay on a coating of metal ten times as thick in less than one-half an hour. In fact this can be done so rapidly that if the solution is not just right the deposit quickly builds around an air or hydrogen bubble and causes at pit; or perhaps it is the nodule of metal deposited on a particle of conducting debris which causes this pit.

Slide: Shows a section of a ni elliptic anode (90-92%). The user did not believe in cleaning anodes, and for once we were glad, for by this specimen we were able to determine the actual nickel loss in the nickel scale. It proved to be approximately 2% of the original weight of the anode or 98c of every $100.00 worth of nickel anodes.

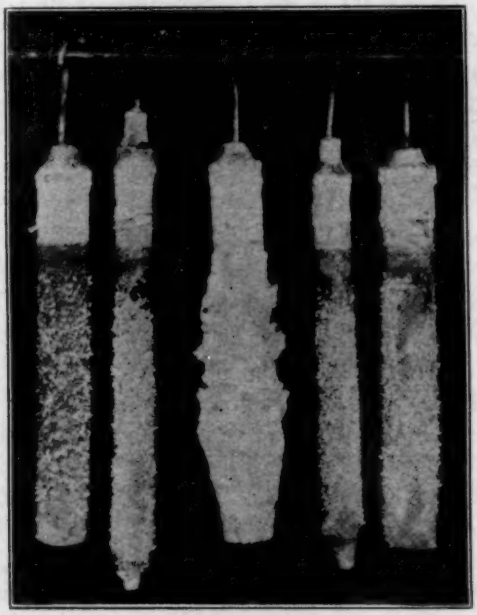
Alkali Copper solutions: There are several uses for alkali copper solutions. They are used for cleaning and copper plating steel in one operation. There is also light copper plating as a finish only. Then there is the solution used in heat treatment of steel. However, the greatest use for these solutions seems to be as a base on which to deposit a heavy coat of nickel. When used for this purpose it is usually used warm. Its efficiency should be as high as possible and still yield a smooth deposit. One that need not be buffed is preferred. If a copper solution has a cathode efficiency of 50% at a temperature of approximately 110° to 125° F. we may expect to get a good copper deposit, if the current is not too high. The current density will vary with the shape of the article being plated and the distance from the anode. If the efficiency is high because of lack of free cyanide we may expect to find that the deposit (*slide*) may be covered with a fine powdery deposit. Under the microscope this powder may look like trees. (*Slide*) If, then, the copper is not buffed, but is nickel plated on top of this moss-like deposit (*slide*), we may expect a rough nodular deposit of nickel. (*Slide*) Sometimes the nodule is knocked off and then there is a mark, such as is shown in this slide, where there is a hole down to the steel.

Slide: This slide shows that other solutions act the same way, for here we see the condition in an acid zinc solution deposit where

the free acid content was too low, as well as one where the acid content is more correct.

Slide: Shows four cyanide copper solutions which were used in multiple and without rheostats. The bottom lines show the ideal copper and sodium cyanide and sodium carbonate content a glance at the lines will show that the metal content has increased about five times, but the sodium cyanide is not in proportion. The sodium carbonate is several pounds per gallon too much, while the $Na_2CO_3 1OH^2O$ line seems to follow the other lines. Therefore we must read the right-hand scale, which is in pounds and not ounces. Two ounces should be enough, but here he has forty-eight ounces, or twenty-four times too much. With this condition of solution, under high current densities there is a tendency for some copper to be deposited loosely or in tree-like formation, which may not adhere, and, since the copper is not buffed before nickel plating, these tree-like formations may be dislodged, even after a coat of nickel has been applied, thus leaving a hole or a pit. Fancy what the salt spray test will do here!

Slide: *Carbonates in Copper and Zinc Cyanide and Other Alkali Solutions*: Sodium carbonate in certain alkali plating solu-



tions has little use except where the cyanide of metals is used, and then in small amounts only. Therefore, we should never add sodium carbonate to a copper or zinc solution, except possibly when the solution is first made. The presence of large quantities of sodium carbonate seemingly does not reduce the resistance of the solution but is said to cause certain roughness of treeing. In the absence of sufficient free cyanide it may be the cause of the heavy, brick-red smut which is often made use of in rose gold and such finishes where a heavy smut is needed. However, in the automotive industries, a bright and smooth as well as a thick deposit, free from trees or nodules, is required, so that nickel may be deposited upon the copper without first buffing the copper. Carbonates accumulate in all cyanide solutions, largely through the decomposition of cyanide by heat or absorption from the air. The odor of ammonia gas arising from a cyanide solution shows that the cyanide is undergoing a change. The partial removal of these carbonates is not difficult. If a solution has a Baume reading of 30 degrees and a low metal content, there may be as much as 2 pounds of sodium carbonate present. About 75% of this amount can be removed by lowering the temperature to the freezing point of 30 to 32 degrees Fahrenheit. If, however, the Baume reading is less than 17 degrees there is little possibility of removing any of the carbonates, and in such a solution it is hardly necessary to do so. Hogaboom remarked on the freezing out of carbonates many years ago. He also stated comparatively recently that the carbonates could be partially removed by heat, i. e., by evaporating the solution one-third and then allowing the bath to cool to room temperature, after which the sodium carbonate will separate out in fine crystals. Then the clear solution may be drawn off and the crystals removed. If the freezing goes to zero or lower the yield will be greater, but some of the other ingredients of the bath may also fall. This shows the amount of sodium carbonate frozen out of twenty gallons of an alkali zinc solution, at a temperature of close to zero, which was then allowed to slowly warm up and drain. The 12-inch rule will give you an idea of the volume of the sodium carbonate. The weight was not taken.

Efficiency of Cyanide Copper Solution: *Slide*: Take two new solutions, one composed of 50 grams of copper cyanide and 85 grams of sodium cyanide per liter, and the other made up with 50 grams of copper carbonate and 100 grams of sodium cyanide

and 2 copper solution which were old. All four solutions were fitted with weighed copper anodes and sheet tin cathodes and connected in series with a copper coulometer. The coulometer was kept at room temperature, while the copper solutions were heated to around 120 degrees F. and worked for one hour at an A. C. D. of approximately 8 amperes per square foot. When the electrodes were weighed it was found that the anodes had worked at 100% efficiency, while the two new solutions and cathodes had worked at 17% efficiency for the copper cyanide with 3.3 ounces of free cyanide. The deposit blistered and was a very dark color. The copper carbonate solution cathode showed a 32% efficiency, while the two old and dense solution worked at 67% and 57% cathode efficiency, according to the quantity of free cyanide present. Of course there was more metal deposited by the old solution, but the deposit was more rough and nodular than that obtained by the new solutions. Believing that the temperature had considerable to do with the cathode efficiency, as well as the free cyanide, another run was made, but only with the two new solutions and at a temperature of 165 degrees F. instead of 120 degrees as before. To our surprise the efficiency of the copper cyanide solution jumped from 17% up to 84%, while the efficiency of the copper carbonate solution went from 32% to 96%. This latter solution gave a good red metallic color and a smoother deposit. The color from the copper cyanide solution was much improved and there were no blisters. Therefore, from these figures we learn that sometimes when a copper solution yields a blistered deposit, heating the solution to a higher degree will cause a better efficiency and a better deposit. Since it is known that high cathode efficiency and current density tend to yield a faulty, heavy deposit (loose and nodular), there seems to be no reason why a satisfactory heavy deposit cannot be obtained from the same solution if a low current density is used. Of course this will take time. You have noticed that all of the copper anodes dissolved at an efficiency of 100%, while the cathode efficiency varied from 17% to 96%. There is, then, a tendency for the metal content of the solution to increase in proportion to the difference between the anode and cathode efficiency. Where the solutions are large and are worked heavy this increase in metal content must be considered seriously, and some method must be employed to overcome this condition, other than running it into the sewer.

The Bureau of Standards: Has shown that nickel plating solutions may not contain more than 5/100 of 1% of zinc, or 3/100 of 1% of copper. Nickel salts seldom contain even this much, but frequently much zinc gets into a plating solution because the plater

or helper uses galvanized pails or tubs in making the solution. When an excess of zinc does get into the solutions, frequently the deposit of nickel will be both black and white with zebra-like markings. *See slide.*

CADMIUM PLATING

Read at 1929 Annual Meeting (Philadelphia Branch)

MR. CLAYTON M. HOFF: Friends, I think I have disposed of one of the old idioms. I had been invited twice, but personally couldn't accept at the time, and the old saying was that what happens twice happens three times. Well, it didn't.

In order that we may make this talk rather brief, I want to outline to you the various points that I expect to cover.

Outline

1. Growth of Cadmium Plating.
2. Variety of Applications.
3. Composition of Plating Bath.
4. Formation and Removal of Carbonates.
5. Anode Design.
6. Computing size of Equipment—
   - a—Still Plating.
   - b—Barrell Plating.
   - c—Mechanical Conveyor.
7. Calculation of Costs.
8. Commercial Consideration.
9. Value of Efficiency.

1. The Growth of Cadmium Plating

In a little over one decade the use of Cadmium for rust protection in this country has grown from almost nothing to a point where considerably over one hundred thousand pounds of Cadmium are consumed monthly for this purpose.

It is estimated that over nine million square feet of surface or more than twenty million pounds of iron and steel are protected against rust by Cadmium each month.

Although Cadmium may have displaced, to a slight extent, other methods of rust protection, the increase in its use is due chiefly to the increase in the demand and a demand for increased rust protection. Due to its chemical and physical properties Cadmium has the advantage of combining rust protection with good appearance. These facts, together with the advantages of obtaining a satisfactory degree of rust protection with relatively thin deposits have been chiefly responsible for the increased use of Cadmium.

2. Variety of Applications

Cadmium always has been and is at present applied chiefly for rust protection. There has been much written and much more said both for and against Cadmium in regard to its merits as a rust protective plate. We shall summarize our conclusions as follows:

a. Cadmium provides for a given thickness of deposit, a greater protection than does other metals used for rust protection.
b. Cadmium is especially resistant to salt water corrosion.
c. Cadmium combines rust protection with an attractive appearance and desirable color.
d. Cadmium when properly deposited is very ductile and adherent.
e. Cadmium possesses desirable electrical and physical properties.
f. There are many applications where Cadmium is more suitable, more desirable and more economical to apply than any other material.
g. The success in the use of Cadmium depends upon a correct knowledge of its properties and the limits of its method of application.

Aside from the foregoing we shall not comment in the use of Cadmium for rust protection but believe it will be of interest to note other applications of electro-deposited Cadmium.

Because it approaches in color aluminum and chromium, Cadmium is used on small parts in contact with or in proximity to these metals on automobiles, airplanes, engines, marine-craft, and utensils. Polished Cadmium is not so different from a chromium plate and the fact that small work is not successfully plated with chromium in barrel plating but quite readily plated thus with Cadmium makes it advantageous to use Cadmium in such parts.

Cadmium is used in ornamental work, as a substitute for silver, as a base for other finishes such as: Flemish Iron, Oxidized Copper, etc. In many cases in order to obtain strength and economy in construction it has been found desirable to replace copper, brass or bronze with steel or iron, protecting it with Cadmium and finishing thereafter.

Cadmium is electrically a good conductor compared to steel or iron and its use in connection with high frequency currents is a valuable one.

The low melting point of Cadmium while limiting the use of this metal in one direction proves an advantage where soldering is required, for example, in electrical and radio work.

Considerable experimental work has been done in the use of Cadmium on automobile cylinder heads, tops of pistons, etc., for the prevention of the adherence or formation of carbon. The results of our tests indicated that while Cadmium *did not prevent* the formation of carbon it *did cause* such deposits as were formed to be *quite soft and easily removable*. These results although interesting, did not have any practical application for at about the same time as these tests were being completed improvements were made in engine designs and in fuels that eliminated most of the carbon formation.

This metal has long been used as a constituent of bearing metal but its use alone as an anti-friction medium was not enjoyed until tests were made by Cadmium plating the leaves of the springs used for support of automobile bodies. Some of the better cars are thus equipped at present, Cadmium acting as a lubricant or anti-friction medium, as a rust preventive and indirectly prevents squeaking and, according to the manufacturers, provides excellent riding qualities.

3. The Composition of Plating Bath

This is perhaps the most important factor to consider in connection with Cadmium Plating for it is this that determines the effi-

ciency, stability, throwing power and electrical properties of the plating solutions, as well as the brightness, ductility, porosity, and hardness of the deposited Cadmium and the design of the Anode and to some extent the design of the plating equipment.

Some of the recent research work on this subject has been very well described by Mr. L. R. Westbrook in his paper "The Electroplating of Cadmium from Cyanide Baths" which was presented at the Fifty-fifth General Meeting of the American Electro-chemical Society, May 28, 1929.

This work consisted essentially of studying the effect of the variation of the amounts of the different ingredients composing a Cadmium plating bath, the trying out of new and different ingredients and addition agents and of different metallic brightness.

In the experimental work the baths have been judged by the character of deposit produced, the electrical properties of the solution and the behavior of the bath under conditions of continuous or intermittent operation over an extended period of time. The plates were examined for adhesion, ductility, uniformity, physical structure and appearance as a finish. Under electrical properties of the solution were included the range of cathode current densities over which bright plates could be secured, the cathode metal current efficiencies at various current densities, conductivity, comparative throwing power, and electrode polarization. Cathode metal current efficiency measurements were based on data obtained with a copper coulometer in series with the experimental bath, and a Haring cell was used to determine conductivity, comparative throwing power and electrode polarization.

or commercial operation it is desirable to have a plating bath .t will function to give a satisfactory deposit with maximum uniformity and efficiency under a wide variation in operating conditions. This involves high conductivity and throwing power, with ability to produce a bright and satisfactory plate over a wide range of cathode current densities at high efficiency. Also the bath should be self-sustaining, or not subject to appreciable variations in composition due to continued use. Hence while Cadmium can be deposited from a simple solution of cadmium cyanide in excess sodium cyanide, the above requirements necessitate the presence of other constituents, as well as a proper balance of the bath composition.

The baths with which this paper is concerned may be considered

to be made up of the ingredients shown in the following table, within the practical range of concentrations there indicated.

Composition of Baths for Cadmium Plating

Ingredients	Mormality		Grams L	
	Min.	Max.	Min.	Max.
Sodium cadmium cyanide NaCd (CN)..	0.4	0.8	45	86
Sodium cyanide, NaCN.....	0.8	1.6	40	80
Sodium hydroxide, NaOH.....	0.5	1.0	20	40
Sodium sulfate, NaSO.....	0.5	1.0	35	71
A brigtener, Ni in small amounts.....				
An organic addition agent.....				

By eliminating the material whose effects were undesirable or inappreciable the following remained as essential ingredients:

Sodium cadmium cyanide	$NaCd(CN)_3$
Sodium cyanide	Na CN
Sodium hydroxide	Na ON
Sodium sulfate	Na_2 SO_4
Metallic brightens (Ni) in small amounts.	
An organic addition agent.	

Confining our attention to these ingredients a study was again made of the results of varying the amount of each one without and with some variations in the others. The results were briefly as follows:

Increasing the *cadmium concentration* results in increasing the cathode current efficiency, conductivity, throwing power, maximum cathode current density permissable, smoothness and fineness of grain size of plate and stability of the bath under continual operation.

Increasing the *free sodium cyanide* constituent of the baths increases the anode current efficiency, decreases the cathode current efficiency and tends to produce smoother and brighter deposits.

An increase of *sodium hydroxide* results in increased cathode current efficiency, conductivity, anode polarization, brightness of deposit, especially at low current densities and ductility of deposit. It is evident that the free sodium cyanide and the sodium hydroxide act to neutralize the undesirable effects of each other while still retaining their beneficial properties.

Variations in the concentration of *sodium sulfate* have little effect on the electrochemical properties of a plating bath. It is used, however, because practical operation has shown the baths containing it to be more stable and operate more uniformly.

Of the metals tried for brightness only nickel, cobalt, and copper Hg proved advantageous. Of these nickel alone did not plate out with Cadmium at normal current densities and was, moreover, more effective than cobalt or copper Hg. The effect of small amounts of nickel in the bath was to produce a smoother, brighter, denser, and more ductile plate of Cadmium. It also increases the range of cathode current densities over which a satisfactory plate can be secured by raising the limiting maximum cathode current density.

An organic addition agent is necessary to secure the physical characteristics essential for rust protection and finish. Of the organic agents Tried, gulac and Turkon Oil produced the most satisfactory results and have the advantage that the amounts used can be varied over a wide range in the recommended bath without producing a noticeable change in the character of the deposit. An insufficient amount results of course in a dull or matte appearance of the plate while an excess may produce a harder and sometimes brittle deposit.

The tests for metallic brightness disclosed facts that many metals act very detrimentally, producing dark, spongy or non-adherent deposits. The metals with which we have worked can be roughly classified as follows:

Nickel, cobalt and copper Hg are beneficial, in proper amounts.

Aluminum, zinc, iron and the alkali-earth metals are ordinarily inert.

Arsonic, antimony, tin, lead and silver are detrimental, arsenic being the worst offender.

As a result of these tests, in which the effects of varying the different ingredients were recorded, chartered and studied it was possible to formulate a bath in which all the ingredients were present in their most desirable amounts. Two typical formulae for Cadmium Plating Baths are as follows:

Ingredients	Concentration, grams/liter			
	General Purpose Bath		Bath for very Bright Plates	
		%		Oz.
CdO	45	3.5	45	6
NaCN	120	10.00	120	16
Na_2SO_4	50	4.2	50	6.6
$NiSO_4.7H_2O$	1.0	.08	1.6	.13-.21
Gulac	12	1.00	..	1.6
Turkon oil	...	.....	12	..

Properties (applicable to both baths), at room temperature.

Specific gravity	1.15
Specific resistivity—ohms per cm. cube	5
Cathode metal current efficiency at 25 amp./sq. ft. (2.69 amp./sq. dm.), per cent	96
Throwing power: Haring cell ratio 5:1 per cent	40
Working range of current densities, am./sq. ft.	15-50
Working range of current densities, amp./sq. dm.	1.61-5.38

4. Formation and Removal of Carbonates

Sodium carbonate accumulates in cyanide plating baths during use from two sources: absorption of carbon-dioxide from the air and hydrolysis and oxidation of the sodium cyanide.

Fortunately sodium carbonate in itself has little effect on the electrical properties of the bath or on the character of the deposit unless present in unusually large quantities. The results in a laboratory test indicated that amounts up to ten per cent had little effect on the appearance of the plate or on the electrical properties of the bath while on commercial baths this limit appeared to be lower about six to seven per cent or about ten ounces per gallon. It is, of course, assumed that the proper proportions of sodium cyanide and sodium hydroxide are maintained.

The chief objection to the formation of sodium carbonate is the fact that proportional amounts of sodium cyanide and sodium bydroxide are in effect removed from the bath, and must be replaced to maintain a normal bath composition. If these ingredients are not replaced the result is lowered conductivity and throwing power, increased anode polarization and defective deposits.

Another objection to the presence of large amounts of carbonates is that it brings the solution nearer its saturation point so that

crystallization occurs if the temperature of the bath is appreciably below normal.

The *rate of carbonate* formation is *decreased* by the use of adequate Cadmium Anode surface, avoiding the use of insoluble anodes and elevated temperatures. A rise in bath temperature should be avoided as this rapidly accelerates the hydrolysis and oxidation of sodium cyanide.

It is obvious that high anode and cathode current efficiencies reduce the formation of carbonate, that a high inductivity prevents excessive heating of the bath and that high concentration of sodium cyanide tends to decrease hydrolysis. All these factors have been taken into consideration in preparing the formula for a Cadmium plating bath. The mechanical loss of solution, with replacement, though small, tends to decrease the rate of carbonate formation. It is interesting to note the results of commercial operation. Of the hundreds of baths of the recommended composition, some of which have been in almost continuous operation for six or more years, only one has required treatment for the removal of carbonates, and this bath, due to the peculiar character of the work, was operated with insoluble anodes carrying one-half of the total current used for plating. Proper treatment for removal of the carbonate reduced it to approximately two per cent or a little more than three ounces per gallon. This plating bath had been in operation for more than three years before the carbonate content became objectionable.

Considerable experimental work has been done on removal of carbonates from Cadmium Plating Baths. Among the materials tried out are calcium cyanide, barium cyanide, calcium cyanide and lime. Calcium cyanide, theoretically the best material to use was found unsatisfactory for the reason that it could not be obtained commercially in sufficient purity. Calcium carbide is the most objectionable impurity forming acetylene. Furthermore, calcium cyanide is so readily hydrolyzed that it will liberate HCN in contact with atmospheric moisture.

Barium cyanide is very expensive and furthermore is impractical because it precipitates the sulfates along with the carbonates, in fact the sulfate is more insoluble than the carbonate. Calcium cyanide reacts very slowly with sodium carbonate in such a bath and furthermore hydrolyzes to a considerable extent liberating ammonia in objectionable quantities.

Treatment with lime was found the most suitable and economical. The results of our experiments indicated that if the plating bath containing carbonates was treated with a ten per cent excess of freshly slaked lime, agitating thoroughly for 24 hours at room temperature or for 3 to 4 hours at around 180° F. the carbonate content could be reduced to about 2 per cent or 3.2 per gallon. For the most economical recovery filtration should be employed for removing the solution from the precipitate. This lime treatment does not appreciably affect the sulfate content of the bath or the cyanide. It does, on the other hand, produce sodium hydroxide which ingredient, of course, had been reduced by carbonation.

5. Anode Design

As previously stated the bath composition is a determining factor in anode design.

If the bath is designed to have a cathode current efficiency of 96 per cent or over it is essential that the anode current efficiency be approximately the same in order that the Cadmium component of the bath remain constant. An efficiency of 96 per cent is obtained at the cathode with a current density of about 30 amp./sq. ft. and the same at the anode with a current density of about 20 amp. per sq. ft. It is obvious then that if insoluble anode surface is used, the overall anode current efficiency is decreased below that of the cathode and by continual operation more cadmium is removed from the bath than is dissolved. It is essential then that if the bath is to be self-maintaining that no insoluble anode surface be employed. This is the basic principle to be considered in the design of an anode to be used with high current efficiency baths.

An anode meeting this requirement is one in which the Cadmium metal is cast around a centrally placed rod or strap of steel which acts as a support for the anode and which in most cases permits all the Cadmium to be dissolved therefrom without scrap or loss.

It has been our experience that in still plating and in mechanical conveyors that to provide the maximum uniformity of Cadmium in the plated work, it is desirable to have the length of the anodes such that the bottom thereof is a little higher than the bottom of the work, the tops of both being just below the surface of the solution.

In mechanical barrel plating it is desirable to have the anode close to the revolving barrel and of such shape that it is approxi-

mately concentric therewith so that the Cadmium is dissolved uniformly therefrom.

6. Computations of size of Equipment

In order to intelligently determine the size or capacity of plating equipment required it is essential to know the thickness of deposit required and the approximate area to be plated.

The basis of this calculation is the time and current required to deposit a definite thickness or amount of Cadmium, which, of course, is nothing more or less than the electrochemical equivalent of Cadmium multiplied by the efficiency of the process. This can be calculated or obtained from tables already prepared.

If we assume for example that a deposit of .0003″-180 amp. is desired we find or can calculate that 30 amp. flowing for about 6 min. at about 100 per cent efficiency will deposit .216 oz. of Cadmium or on one square foot of surface a thickness of .0003″. Twenty amperes for 9 min. will, of course, neglecting current efficiency do the same.

Then in a still plating tank if we allow, for example, 4 min. for loading and unloading it, and a plating time of 6 min. we have a cycle of 10 minutes or six changes or loads per hour. Then, for example, if we have 6000 sq. ft. of work to plate in a day's time of 10 hours or 600 sq. ft. per hour, we would have for each load 100 sq. ft. the work on one load would occupy a space in the tank about 5′ x 10′. The character of the work will determine to some extent the dimensions of the tank, sufficient space being provided between the racks so that they do not overlap. For uniform work a tank 14 ft. long, 6 ft. deep, and 2½ ft. wide would be sufficient to accommodate the aforementioned work.

The generator size is determined by the current that is required for plating and cleaning (if electrolytic cleaning is used). One hundred square feet of work at one load at 30 amps. per sq. ft. would require a capacity of 3000 amperes and allowing one-half of this for electrolytic cleaning a total capacity of 4500 amperes at 6 volts would be required.

For efficient solutions such as described about two amperes per gallon are allowable for continuous operations in still plating without heating of the solution. This would indicate a solution volume of 1500 gallons which checks approximately with our estimated dimensions which show: 14 x 6 x 2½ = 210 cu. ft. x 7.5 = 1575

gallons completely filled or approximately 1500 gallons at a working level.

The calculations for a mechanical conveyor equipment are similar with the exception that the time allowed for loading and unloading (for example 4 min. in the foregoing case) may be eliminated or greatly decreased for the equipment may be operated at almost full capacity all the time. The generator size may therefore be decreased somewhat.

In mechanical barrel plating the same principle applies. Using our previous example assuming, however, that we have 600 sq. ft. per hour of small work instead of large pieces to plate. Assuming the same thickness of deposit which will require 180 ampere minutes per sq. ft. or 3 ampere hours per sq. ft. we have required 600 x 3 or 1800 ampere hours per hour; which if the plant is operated continuously for the required period would require a generator of 1800 ampere capacity at the voltage required by the equipment.

If we use a plating barrel operating at 300 amperes we would require six such barrels operating continuously, each barrel plating 100 sq. ft. per hour. Different equipment will accommodate different loads but in all probability such a barrel should have 50 sq. ft. per load with two loads per hour. Inasmuch as some time is lost in loading and unloading the regular practice would be to employ two additional barrels keeping in actual continual operation. A plating barrel equipment accommodating 300 amperes should have from 100-150 gallons capacity for proper operation in the recommended bath.

7. Calculation of Plating Costs

For convenience the costs of Cadmium plating may be divided as follows:

Labor
Overhead
Metal Solution
Power

Some costs are calculated per price, some on units of weight or that it is difficult to provide any exact outline that will be adaptable to all products or conditions.

There are some facts that are of interest however, though obvious, one that the labor and direct overhead in plating bear a reciprocal relation to each other. By the use of more mechanical

equipment for handling purposes the overhead is increased and the labor decreased and vice versa, and the other that the ratio of surface to weight of the work plated has a special significance when we are plating with a relatively high price metal.

It is this factor which frequently determines what material can be most economically used for rust protection.

8. Commercial Consideration

We do not believe that determining the factors which constitute an efficient plating bath for Cadmium is in itself sufficient.

It is also desirable that all the ingredients be, if possible, provided in dry form to reduce shipping costs, furnished as one compound to avoid chances of mistakes in making up a plating bath, and that maintenances of the solution be simplified as much as possible.

Convenience and safety in handling the materials for the plating bath should also be given considerations.

9. Value of Efficiency

It would seem perhaps that too great an emphasis has been placed on high current efficiencies. The question might be appropriately raised, why work for high current efficiencies when electric power cost is the smallest item in plating cost.

If power costs alone were to be considered it might be amiss to emphasize current efficiencies. However, there are other and more significent factors to consider. It is not the current that we use that counts so much as the current we lose. Every bit of current that is not used in carrying metal from the anode into the solution tends to create an oxidizing action at the surface of the anode with the result that some of the sodium cyanide of the bath is converted to carbonate. This increase in carbonate in turn tends, through increasing the resistance of the bath and the anode poralization, toward a further increase in the carbonate content, thus establishing what is termed a "vicious cycle."

At the same time if the cathode current efficiency is not decreased the bath is *depleted* in cadmium *content* with the result that the character of the deposit suffers.

To recondition or maintain such a bath requires the frequent additions of not only sodium cyanide but cadmium in the form of a salt or compound which as we know is more costly than metallic cadmium and introduces another negative radical which tends to *accumulate* with undesirable results.

By employing high current efficiencies not only are economies effected in power and in chemicals but the maintenance of the solution is greatly simplified.

Interpolations to Mr. Hoff's Paper

Page 1. (1) I say "rust protection." I wish we could say rust proofing, but there is no such thing as absolutely rust proofing yet, so we will limit ourselves to rust protection, which is a much better experiment.

Page 8. (2) I might at this time mention the fact, or show you some photographs representing the different deposits obtained with different mixtures of the bath. Unfortunately, we haven't a blackboard here, but we can pass these around. (Distributes photographs.)

We have photographs of six different deposits. Starting out with No. 1, that is a deposit made with Turkon oil in the bath of the recommended formula. Deposit No. 4 is one made with gulac, and the others are different formulas which are used commercially, No. 6 being one which is advocated as being available at any time without infringing on any patents or anybody else's formula. And No. 7 is practically the same bath as recommended in No. 6, with the exception that mercury has been added to that which reduces the grain size very greatly and produces a much better deposit. Although you won't remember all the different plates here, you will see the difference of deposits represented by the different types of solutions. The most noticeable fact is the roughness of the deposit, and you can judge the density of the deposit to a considerable extent by the size of the wire from which a single experimental plate was supported. I might say for further explanation that these plates were plated by plating at 20 amperes per square foot for twenty-four hours in order to bring out the defects in plate that you can't ordinarily see if they are plated just for a few minutes. Those conditions you can see under the microscope to some extent, but they are brought out if the plating is continued for a long time; those defects are magnified and the result which you have here is a plate of 24 hours' duration, each bath being connected in series so that the same current was used through all bath.

Page 12. (3) I have some photographs taken of anodes that have actually been in use until they have been practically used up, and you will note from this photograph—upon these photographs,

they are duplicates, that the cadmium metal in the anode has been reduced to less than perhaps one-twentieth of its original amount without any appreciable steel being exposed.

CHAIRMAN LUKENS: Mr. Hoff has not disappointed the member of the committee who recommended him so highly, I am quite sure. He has touched upon practically all phases of this subject which is becoming of increasing interest to all of us, and I would remind you that this is your meeting, that this is your opportunity to ask Mr. Hoff any questions that you may desire. He has very kindly volunteered to answer any questions in so far as he is able.

MR. JOSEPH MUIR: What is Turkon oil?

MR. HOFF: Turkon oil is the name applied to one grade of sulphonated castor oil. It is an organic compound used in the dyeing industry as a wetting agent. "Turkon oil" is a trade name.

MR. WILLIAM WILLIAMS: What kind of anode do you consider the most efficient?

MR. HOFF: For a cadmium plating solution having high current efficiencies, an anode that presents no surface but cadmium surface to the solution is the most efficient, and providing sufficient anode surface so that you will have a current density not over 20 amperes per square foot on the anode. Any given type of anode, of course, must be designed to meet the requirements of the equipment and the requirements of the work being plated.

MR. ROBINSON: Is there any method for determining the amount of gulac in a plating solution?

MR. HOFF: There is no direct method or easy method of determining the gulac in a cadmium solution. The method we use is entirely the colorimetric method, taking a solution that has been used and a new one and filtering it, and if the solution is weak, of course the amount of gulac will be lower, and should be lower in proportion to the amount of cadmium that is there. But if we should have to test a solution that is below the normal strength, it is best to take a known solution or a standard solution containing the proper ingredients, and dilute it until it is the same gravity or better, having the same cadmium content as the weak solution, and then compare the two colorimetrically. That is not exact, and the comparison does not have to be exact because we have selected gulac and Turkon oil because they are not critical.

You can use twice or half as much with almost the same result.

MR. JOSEPH MUIR: Is gulac an organic substance?

MR. HOFF: It is a by-product of the paper pulp industry. We don't know what it is, but it is composed chiefly of lignon sulphorate.

CHAIRMAN LUKENS: Gulac first came into prominence through its use in copper refining, where it is used to modify the characteristics of the crystal structure, and that doubtless suggested its application to this purpose, I presume.

MR. CHARLES H. PROCTOR: Isn't the proper name of gulac "lignone?"

MR. HOFF: No, I believe not. Gulac is again, you might say, a trade name, a trade name which has been used so much that it has lost its capital letter, however, and I believe it is composed chiefly of lignon sulphorate.

MR. ROBINSON: You spoke of hydrolization, is that it, of sodium cyanide, forming sodium carbonate. Does that have any tendency at all to affect the plating surface of cadmium?

MR. HOFF: Not directly. You mean the plating surface as the character of the surface plated, the brilliancy of the deposit?

MR. ROBINSON: Yes.

MR. HOFF: If you turn the sodium cyanide into sodium carbonate, the amount formed has no effect, but its decrease in the amount of sodium cyanide has the effect, produces a duller deposit.

MR. ROBINSON: That wouldn't be an oxide, would it, on the cadmium surface?

MR. HOFF: No, it is a different state or character of the grain size, or the grain formation. It is a matt surface instead of a bright surface, but very finely divided crystalline structure.

MR. FRANK MacSTOKER (New York): I might ask Mr. Hoff if it is not true that such an anode can be one with 1% or 2% of aluminum, in a cadmium plating bath; if so, if he knows of any advantage.

MR. HOFF: I do not know ot any anode containing 98% cadmium and 2% of aluminum being used. The effect of that, I would predict, would be to produce un-uniform corrosion of the anode to a certain extent; but the effect of the aluminum would be practically nothing at all. It might act as a brightener in some

(Continued on page 35)

A. E. S. PAGE

Assembled Expert Scraps With and Without Significance

Are you a book-keeper? The kind that borrows a book and keeps it?

Where is Secretary Gehling's copy of Prov. Convention Reports?

He's Right Too

Teacher—"Now, Herbert, how many season are there?"

Herbert—"Do you mean in the United States?"

Teacher—"Yes."

Herbert—"Two."

Teacher—"Only two? Name them."

Herbert—"Baseball and football."

—*G. Boehm.*

After years of research, scientists have discovered that the kind of hens that lay the longest are dead hens.

Poor Kid

Farmer: What are you doing up in my apple tree?

Small Boy: Believe it or not, mister, I just fell out of an aeroplane.

Our Greatest General

Miss Phillips: "Willie, who is America's greatest general?"

Willie: "General Motors."

Getting Even

A thin man resented the lateral pressure of a fat man on the same seat in a street car. He said: "They ought to charge by weight in these cars."

"If they did, sonny," said the fat man, "you'd have to walk. They couldn't afford to stop for you."

—*P. Sandell.*

Weather Report for Mexico

Chile today; Hot Tamale.

We Can't Blame the Officer

Policeman (producing notebook)—"Wot's your name?"

Motorist—"Aloysius Alastair Cyprianus."

Policeman (putting book away)—"Well, don't let me catch you again."

—*L. Kramer.*

way, although we haven't ever been able to detect that aluminum acted as a brightener in a cyanide solution. The aluminum, iron and other materials in a cyanide solution, are usually inert because they are usually insoluble, although in the case of aluminum they are soluble in most solutions because it forms the sodium aluminate. I might say in this connection that ferric hydrate or insoluble material in a solution is not objectionable in itself, but it is objectionable to this extent, that it acts as a carrier of small metallic particles and causes pitting.

Now I have a question to ask. Before I ask my question, I want to lay the foundation for it. We are plating some high carbon steel. It is made from spring wire which is of a rather high carbon content, and the plating of cadmium does not seem to embrittle the steel under ordinary conditions. However, if some portions of this wire are compressed or flattened, the steel becomes very brittle. Why does it do that? Now you may answer the fact that hydrogen may be absorbed from the portion under strain. That would answer the question very well if it were not for the fact that we get the same hardening whether we have the current on the bath or whether we let the material stand in the plating bath. Is that a case of cyanide hardening, hardening from cyanide solutions? I don't know, but would like to have an answer to it.

CHAIRMAN LUKENS: Can anyone offer anything in any degree to compensate Mr. Hoff for his kindness to us already? Has anyone any information on that point? . . . I am sorry, Mr. Hoff, we are not able to aid you.

MR. MESLE: Would it be possible for the pickling prior to plating to have influenced the hardening of the steel?

MR. HOFF: No, we have tried it with and without electrolytic pickling and by cutting out each or all the steps in the plating, and we got the same results.

CHAIRMAN LUKENS: Is there any further information available on that? Any further questions? Have you any further questions, Mr. Hoff?

MR. HOFF: Yes, I have one more. In the electrolytic cleaning of so-called cold rolled steel in an ordinary bath, Oakie or Wyandotte or anything similar may be used, using the work as an anode, in that solution, work to be chromium plated has also been dipped. When the work is used as a cathode instead of the anode, the surface of the metal cleaned acts toward cadmium plating or

toward the plated cadmium the same way that chromium does. That opens up something very interesting. I don't want to get into chromium plating in this talk, but the very fact is this: We have taken a piece of chromium work and tried to cadmium plate on top, and found the result is that the cadmium plates on there uniformly, but you can peel it off as if there were grease between it. The same thing happens when we use an electrolytic cleaner making the work the cathode in a solution which contains some of the rinse water from chromium acid plating.

DR. A. KENNETH GRAHAM: I just want to venture the opinion that when you use the work in the cleaner as anode, that there is a tendency to produce a film on the work greater than if you cathodically cleaned it. And where you use that solution containing the rinse water from chromium plating, that would tend to increase the passivity of the surface, and that in itself would in part explain that condition. For instance, if you take chromate itself, you can impart a passivity to your surface so that the plate will peel.

MR. HOFF: I think one point I didn't perhaps emphasize enough was that using the work as the anode, plating was very satisfactory, but using the work in the plating bath as a cathode, why we got non-adherance. Absolutely non-adherance. I don't believe we are plating out chromium from the plating bath but it would be very nice if we could.

DR. GRAHAM: I might say that immersion of a plate in the chromate solution without any current or without having a cleaner there would in itself tend to promote passivity, and cause peeling, regardless of whether the work was in the cleaner as anode or cathode. If chromic acid or sodium chromate is the contaminating cause, it could be explained on the basis of passivity.

CHAIRMAN LUKENS: It might be interesting to polarize the work before introducing it into the bath, which would perhaps answer that question, Dr. Graham. Polarize it as a cathode before introducing it.

MR. CHARLES H. PROCTOR: I would like to say a word in regard to the embrittlement of steel. I think Dr. Blum remembers that during the war period there was a conference held in Washington by the military authorities where the embrittlement of high carbon steel springs was taken into consideration. I

think at that time it was determined that hydrogen was the factor that caused the condition, and it might be inferred that when a piece of steel, as Mr. Hoff mentions, is immersed in a cadmium bath, there might be sufficient hydrogen and the steel might absorb it.

CHAIRMAN LUKENS: If there are no further questions, Mr. Hoff, I sincerely thank you on behalf of the members of the section for this very instructing and suggestive address.

A. E. S. ANNUAL CONVENTION

Come to Washington, D. C., Educational Bee and Make a Little Whoopee—But Do Not Forget Your Certificate from Railroad, It Means One-half Fare One Way. Heh, Heh

The Annual Convention of the American Electroplaters' Society is to be held this year at the Mayflower Hotel in Washington, D. C., on June 30, July 1, 2 and 3. Splendid accommodations can be obtained at the hotels at very reasonable rates. As the day following the Convention is a holiday (July 4), it will be convenient to spend the rest of the week in Washington seeing the many sights. This would make a wonderful vacation for the whole family.

BY LAND . . . . .

OR SEA . . . . .

OR AIR . . . . .

We only need 125 certificates when we purchase our ticket to get one-half fare back home. Get one.

Committee.

PAST PRES. GEO. B. HOGABOOM: QUESTION BOX

Philadelphia 1929 Annual Meeting

Dr. Lukens has given me quite a task, and I think he has exaggerated the point quite some. But due to his enthusiasm, I forgive him.

The question box was tried out here last year, and it was quite a success. We have tried it several times during the year, last winter, and three times so far this winter, and every time it has created a great deal of interest, and while the speaker does not for a moment try to state that every question will be answered, nevertheless, he is acquainted enough in the audience with some fellows that can help him out if he gets stuck.

This question box was established for this reason, that when papers are read, it is generally the plan to adhere to questions relating to that paper.

Now there are a number of fellows come to a meeting that have some particular problem of their own which does not come under the heading of the paper, and it is to give these fellows a chance that we have the question box. So start in.

MR. MACSTOKER: I might ask Mr. Hogaboom if he would inform me and the folks assembled of the use of potassium chlorate in a bronze solution and what its functions are.

MR. HOGABOOM: Dr. Graham.

DR. GRAHAM: I think I know where that question came from. (Laughter.) I think it is common knowledge that bronze solutions have been successfully operated with small concentrations of free cyanide, and with additions of cream of tartar or Rochelle salts. The tartrates, cream of tartar or Rochelle salts, have an effect there which is beneficial. They apparently clear up the solution and keep your anodes clean. It came to my attention recently that additions of sodium chlorate had been made to a bronze solution and it had accomplished results which were quite satisfactory, as far as I could see. I think more is to be learned about it, but certainly it had a very pronounced effect, and was in a measure quite similar to that of the other factors, of adding cream of tartar. Now the only information I have to give,—if it has the same effect it must operate in a similar manner. We know that the chlorate radical is quite stable, therefore it would not readily be reduced under ordinary

conditions, and it apparently attacks the anode, and it takes the product formed there, in the solution, and keeps it clean, and it also keeps the solution quite clear in the same way that other additions have done. That is as much as I can tell you.

CHAIRMAN LUKENS: May I say a word? I wonder if the question has ever been investigated regarding the relative rates of migration of the ClO3 ion as compared with the other ions that are present? It is my impression that it moves quite a little faster, which would account for the ions at the anode going into solution perhaps as chlorate and later being transposed into the other component present.

MR. SIEVERING: May I ask why the same substance can't be used in a brass solution?

MR. HOGABOOM: The trouble with bronze solutions is that you can not use high free cyanide. Just as soon as you use high free cyanide in a bronze solution you will get a brass, regardless of the composition of the solution or the composition of the anode, and therefore you must use a low free cyanide. Just as soon as you use a low free cyanide, your anode will coat over, there will be products formed at the anode which won't go into solution; therefore it is essential to have some product in that solution which will dissolve the products which are formed at the anode to keep the anode clean. Because if you have an anode that is polarized, coated over, then you must use higher current densities—I mean a higher pressure—to get a certain current density. When you use that higher pressure, then you change the relation of the zinc and copper, which is being deposited, and therefore change the color of your deposit. If you can keep a clean anode, then you can run a solution with a reasonable pressure and get a good high current density and still maintain a uniformity of color.

I found, in the operation of several thousand gallons of bronze solutions over a number of years, Rochelle salts did that very thing. If you will add Rochelle salts to the solution, you will notice that directly next to the anode—I made a statement not so very long ago, about an inch, but I was exaggerating because a fellow called me for it later,—probably a quarter of an inch from the anode you will note that the solution is distinctly green, and then the solution will come out to the wine color. Now if you do not have enough Rochelle salts in the solution, there will not be that green area next to your anode, and your anode will

not be clean. And if you have too much Rochelle salts in the solution, then there will be gassing at the cathode which will irritate the nostrils. Not harmful, but irritating. So that you can balance your Rochelle salts in that way, and you can then use the low free cyanide.

Now in a brass solution you can use a free cyanide high enough to keep the anode perfectly clean so there is no need of doing that. And the less chemicals you have in the solution, the more easy it is to operate. And if you can operate a brass solution with a cyanide that will keep the anode clean, why add it?

The trouble with brass solutions, in my opinion, is that the zinc content of the anode is often much higher than what the zinc content of the cathode requires. If you want a cathode that is a certain color, then you should analyze that cathode to find out what the copper/zinc ratio is. Then make up your solution and your anode accordingly. But you don't need to go to the point of making it exact. If you want, for example, an anode or rather a cathode, containing 75% copper and 25% zinc, you can use an 80/20 anode and then add zinc from time to time, because it is much easier to add zinc to a solution than it is to take it out. And if you have an 80/20 anode, then you are assured of a clean anode. And therefore you are assured of a uniform color, and a better distribution of the deposit. So that by having a zinc in your solution a trifle less than that which is required in the deposit, it is quite possible to keep an anode perfectly clean. But if, on the other hand, you have higher zinc in your anode, and you have to repress that zinc and keep it down so that it don't go over into your cathode, so as to give an off color, then you are in trouble, and you get a clogged anode, you get the white sludge at the bottom of your tank and a variation of color.

MR. SIEVERING: I am not quite satisfied yet. The question is this: If you can use Rochelle salts, that is a more stable ingredient than cyanide is. Wouldn't it be an advantage saving cyanide in a bath if the Rochelle salts were used in brass as well as in bronze?

MR. HOGABOOM: I can't tell you about that. Dr. Watts has written a very excellent paper on that, and you will find it in the Transactions of the Electro-Chemical Society, and he advises the use of Rochelle salts in a brass solution. That is what gave me the idea of using it in a bronze solution, due to Dr. Watts' paper,

and it is quite possible that Rochelle salts may act equally as well as cyanide and may be able to maintain the solution at a better equilibrium. That is quite possible.

MR. SIZELOVE: If it works in a brass solution, why can't it be used in a cyanide copper solution?

MR. HOGABOOM: That is quite true, but I am surprised to have a man of Mr. Sizelove's intelligence asking such a question. He uses the most careful analysis to control his solutions, and then asks about such a simple thing as a copper.

MR. SIZELOVE: The same as a bronze solution, with our noses.

DR. GRAHAM: Referring to the use of potassium chlorate in a brass solution, I really think that until we have more information as to what effect that has on the analysis of the solution, and how it can be controlled, either chemically or by practical experience, that it would be well to add it very cautiously or do it experimentally. We haven't enough information on how it behaves to really justify its use.

MR. HOGABOOM: That is true. You take the addition of caustic soda to a brass solution. You can't get an end point with silver nitrate, just a normal silver nitrate titration, if you have caustic soda in a brass solution. If you have no caustic soda present, you can, but just as soon as you put caustic soda into your solution, the end point is off, even if you do precipitate the carbonates with barium nitrate. And the caustic soda prevents the end point, so the chlorate may do the same thing.

MR. MacSTOKER: A small proportion would do that?

MR. HOGABOOM: Yes. I was very much surprised at that because it was my opinion that caustic soda would not interfere and probably with the barium nitrate it would precipitate, but I learned that it does. We added just a few drops to about 50 c.c.'s, and just as soon as we did, we got an off end point, and we couldn't duplicate results correctly with the silver nitrate. But when we had no caustic soda, we could.

You are going to hear more about brass solutions and caustic soda, and the addition of brass solutions, as time goes on. Brass solutions are being operated directly under pH control. And in the pH control, you will find that caustic soda should only be added to correct pH, and one of the very worst things that you can add to a brass solution is sal ammoniac. It is a poison, almost,

to a brass solution, and it makes the pH very erratic, and makes the color go off, and you get all kinds of variations in your copper/zinc ratio. But you will hear more later on. I am just telling you that brass solutions are going to be controlled by colorimetric pH.

MR. MUIR: That pH applies to brass or only cyanide brass?

MR. HOGABOOM: Cyanide brass. That is the only solution you use in which there are carbonates. Carbonates form in a brass solution through the gassing; the spray comes up in the air and falls back as carbonates, and then the decomposition of cyanide. In still tank work, the drag-out is such that your carbonates may not build up, but mechanical platers, where the dragout is not great, I have seen brass solutions run as high as 32 ounces of carbonates per gallon. Now you come to titrate that for free cyanide, in such a solution, and you can't do it. But if you will remove the carbonates by the addition of barium nitrate and then titrate that clear solution, you can get a very sharp end point, and it will be accurate and duplicate the results.

MR. SIEVERING: I want to ask another point on brass solutions. Take a brass solution that has been in existence ten or fifteen years, that is never taken out or additions made, and the carbonates only rise to three ounces per gallon. Is that possible?

MR. HOGABOOM: I am surprised, a man of Mr. Sievering's ability should say a solution is fifteen years old when Nixon, for example, and others (I did some work myself) found that in regular practice that your drag-out is sufficient to take and make a new solution once every seven months.

MR. SIEVERING: I am only saying the solution was in the tank for that length of time, except the additions made.

MR. HOGABOOM: But your drag-out is sufficient to take care of it.

MR. SIEVERING: Evaporation, too, but we have those conditions existing in my place, and we have made a test of the carbonates and found we only have three ounces to the gallon.

MR. HOGABOOM: The drag-out in a still tank is quite sufficient to take care of the carbonates. They don't build up so awfully rapid, and when you drag out, if you calculate your drag-out, you will find that it just about takes care of the carbonates.

MR. SIEVERING: How do you account for the rise in specific gravity or hydrometer test in a solution of that kind,

taking the density, not the amount of the salts? There is always a gradual rise in the density of solution.

MR. HOGABOOM: I don't know. I never saw it. I never saw a rise in specific gravity. I have operated brass solutions a number of years but never saw an increase in specific gravity, unless it is in the free cyanide, and your free cyanide would be difficult, whereas if you removed the carbonates to take and titrate and your free cyanides may be higher than you really believe they are on account of your methods of titration.

Clinnel stated in his book on cyanides that zinc interfered. We found that was not true. We found that zinc did not interfere; that it was the carbonates that interfered with the cyanides. And your cyanide concentration may have changed and not having a good method for titrating, just merely the decimal method, it would be difficult.

DR. GRAHAM: I think it would be clearer to the Philadelphia group if you would explain carbonates of cyanide increase proportionately, that is, the amount of cyanide present must increase with the carbonates. They haven't heard your paper on brass.

MR. HOGABOOM: It is difficult to make that statement. We operated a 2300 gallon solution, full automatic, and the carbonate content increased up to from about four ounces to thirty-two ounces per gallon, in a year. Now that solution was run at 100 degrees F., and was operated at 2300 gallons, was operated at approximately an ampere per gallon, a little over that,—2500 to 2800 amperes. Now in a study I made of brass solutions, additions were made of carbonates, two ounces at a time. We found that where the carbonates got up to eight ounces, there was your optimum point. Just as soon as you began to get above that, your cathode efficiency greatly decreased. When you got twelve ounces per gallon, it acted exactly the same as free cyanide and kept a very bright anode. Then when you get to 16 ounces, it would dull again, and then when you get up to 24 ounces, a peculiar thing, the conductivity of the solution greatly increased; it was about three times that of the solution containing 4 ounces of carbonates, and sometimes the cathode efficiency was only 50% of what it was when it was 4 ounces. That was evidently due to the gasing caused by the carbonates in solution.

Now I had quite a talk on that, gave it at Detroit, gave it at Newark—it was illustrated—and if the Philadelphia Branch

wishes, why sometime I would be pleased to show them the pictures.

MR. SIEVERING: One more question. You say the solution builds up from 4 ounces per gallon up to 32 ounces per gallon. Doesn't that increase your hydrometer readings?

MR. HOGABOOM: Yes, that does.

MR. SIEVERING: That is the point I was trying to get at before.

MR. HOGABOOM: Yes, surely that increases the hydrometer reading. I didn't catch that point. I can actually give you those figures sometime, because I have them. Because we took specific gravity readings of the solution three times a week for a year, and made analyses three times a week for a year, and that is what we got, and I've got probably five years of those analyses.

MR. SIZELOVE: I have a question. What advantage is there in adding caustic soda to a cyanide copper solution—or disadvantage?

MR. HOGABOOM: I can see no advantage except you may increase your conductivity. Now it is quite possible that you may change the character of the chemical action at the anode. I couldn't tell you. I don't know anything at all about it. Do you, Dr. Lukens? Suppose you add caustic soda to a cyanide copper solution?

DR. LUKENS: I would anticipate it would tend to increase the conductivity, although the addition of ammonia would tend to operate in the opposite direction, and have a brightening effect on the deposit.

MR. SIZELOVE: A copper solution that has a tendency for the deposit to raise or blister can be overcome by adding caustic soda to that solution.

MR. HOGABOOM: Isn't that more due to the cleaning effect? You are getting a cleaner and plater? And a deposit that comes from a cleaner and plater, you can't peel. That is probably the condition there, I think.

MR. SIZELOVE: I notice after that caustic soda has been added there is more gas generated at the cathode than previously.

MR. HOGABOOM: Probably the cleaning effect, which increases conductivity.

Any other questions? I move we adjourn. I haven't been well

and that is why I am nervous and not very strong, so you will pardon me for trying to close it up.

CHAIRMAN LUKENS: Gentlemen, I see that I was mistaken. Mr. Hogaboom is not courageous; he has nothing to fear.

I want to take this opportunity of thanking again our speakers who have seen fit to go to the trouble and effort of coming here and addressing us; and to thank those of you who have joined in the discussions and made them most interesting.

"STANDARDS"

By D. H. Simpson*

A Paper Presented at the Eighteenth Annual Educational Meeting of the Chicago Branch of the American Electroplaters' Society, January 18th, 1930

This paper is based on the ideas contained in the two following quotations from bulletins sent out by the American Standards Association:

"If any industrial organization works smoothly, it is because many things have been standardized."

"As soon as any achievement has been standardized, it becomes a step upon which to build, a means by which to grow. It has been said that standards are the ratchets that catch and support progress. No matter how great the advance made by any individual, if the advance does not take the shape of some standards, the gain will disappear with his death, and society will slip back to where it was before his discovery."

* * *

"Standardization is the one thing which enables us to take advantage of what the human mind is discovering and contriving."

The idea of established standards is not particularly new; in fact, certain concepts of standards existed in the early history of man. It is obvious that the earliest form of community life necessitated certain standards of relation, such as common speech, picture writing, and division of time.

With the development of barter and exchange additional standards, such as definite rules of action, money, and weights and

*Edison Electric Appliance Co., Inc.

measures, arose in the natural course of events. These "standards" are evident in the development of all peoples of all times and their number increases with advancing development of culture.

It would be possible to trace the development of standards through the entire history of industry, but such is not within the scope of this paper.

The terms standardization and standards are defined by Norman F. Harriman in their modern meaning in this connection as follows:

Standardization may be defined as the unification of methods, practices, and technique involved in the manufacture, construction, and use of materials, machines and products, and in all lines of endeavor which present the necessity for performing repetitive work.

Standardization primarily means the setting up of standards by which extent, quantity, quality, value, performance, or service may be judged or determined. It is the crystallization of the best thought and practice of industry, business, or art into definite forms for general usage.

A standard is a carefully drawn description covering the necessary characteristics of a material, a machine, or some article of stores or product, or a method of performing a function. Such a standard is not to be considered perfection, but is simply the best that can be devised at the time and covers all the points of variation which it is possible or desirable to consider at the time the standard is set up.

Standardization did not receive much consideration in industry up to the time of the World War. One notable exception is the case of the railroads which had carried out a program of standardization in order to facilitate interchangeability. In earlier days there had been many different track gages, sizes and shapes of cars, and patterns of parts, especially such as coupling pins; as a result, cars of one line could not be carried on another line and all goods had to be transferred at every change of line. The railroads began using uniform track gages, then box cars and couplings and thus made equipment interchangeable. The great benefits resulting from this standardization in industry are too obvious to require enumeration.

In general, however, the progress of unification and coordination was very slow until they were forced upon industry by the demands of production to meet the exigencies of the War. The won-

derful economies possible began to be better realized and the idea of standardization has been more widely adapted until now it is one of the most modern aids to industry and is of great importance to both producer and consumer.

The question frequently comes up, "Does standardization benefit the consumer or producer?" The answer is that retailers, wholesalers and consumers in general are ultimately benefited the most by industrial standardization. The immediate profits are largely to the producer because he can produce what the consumer wants easier, quicker and more cheaply.

It is naturally true that the highly centralized standardization work is found mainly in the larger companies. However, organized, systematic programs for the development of standardization are found in practically every scale of industrial operations. There are many variations in the plans and in the completeness to which the standardization is applied.

There is scarcely a manufacturing or commercial enterprise in the entire country which cannot show a financial profit almost immediately by even a limited amount of standardization effort. In a book entitled "Scientific Purchasing" written by Gushée and Boffey, there is an illustration of a small chain of hotels, operated under one management, but each hotel handling its own buying to suit the ideas of each individual manager. A limited degree of standardization was established applying to chinaware, carpets and linen used by all the hotels. One design of chinaware, three types of carpets, and a greatly reduced line of sizes and grades of linen were bought through a central purchasing department. As a result there was a direct saving of $100,000 a year as compared with amounts previously spent for these items and the reduction of inventory made possible by standardization released $350,000 in capital.

Plans for standardization may include any or all of the following details or others which are not mentioned:

Methods.—Adoption of the one best and most economical method of doing each thing as taught by plant and engineering experience, and making it standard practice.

Products.—A standardized product made to definite specifications permits an output to the maximum uniformity possible within the limits of manufacturing skill.

Variety.—Elimination of unnecessary types, grades, shapes and sizes of articles or materials.

Quality.—Standardization of quality is of especial importance to the purchaser and user of commodities. The best and most economical way to get the desired quality of any item purchased is by the use of adequate purchase specifications.

The object of a specification is to inform the vendor definitely as to what the purchaser wants. It is a common meeting ground and embodies at once the user's needs and the maker's ability to produce. Business is facilitated and causes for disputes are avoided if purchases are made on the basis of definite specified qualities which are understood by both the vendor and purchaser.

Purchasing materials and supplies on the basis of specified quality and performance permits and encourages competition, which results in more favorable prices than can be expected when the same item is purchased by a trade name or brand.

It should be understood by all concerned that items purchased by specification are to be tested in the laboratory to make sure that the specified qualities are maintained in the product.

In our company we have a definite program of standardization on which we are constantly working. In the Engineering Department the work is divided as follows:

GENERAL STANDARDS:

Finishes

Enamel and Japan.
Vitreous Enamel.
Lacquer.
Nickel Finishes.
Colors.

Raw Material Sizes

Sizes of sheets, strips, bars, etc.

Standard Gauges

Gauge systems to be used in measuring various materials.
Weight of materials.

Standard Hardware

Screws, bolts, nuts, rivets, etc.

QUALITY STANDARDS

Formulation of Material Specifications for purchased materials.
Testing materials to be sure they meet requirements specified.

PROCESS STANDARDS

Process specifications.

All of this work of standardization has resulted in great sav-

ings to the company. One instance of saving is the reduction in stock of sheet steel. Where there had been 276 different sizes of sheet steel carried in stock in large quantity, it was found possible to reduce the number to 121 sizes and at the same time reduce the scrap losses.

Now let us consider how this standardization works out in the development of a new item which is to have a nickel plate finish.

1. *Grade of Stock (Material Specification)*

The grade of stock to be used is specified in the material specification as to composition, temper and the condition of the surface to reduce polishing to a minimum.

2. *Grade of Finish (Finish Standard)*

(a) *Polishing.*—In general, grades of finish are distinguished by the smoothness of the polished surface. This smoothness is determined by the number of polishing operations, so the different grades required are tabulated in the specification according to the number of polishing operations for hand work. If a part is polished by machine the surface produced must be equivalent to the surface specified.

(b) *Thickness of Nickel Deposit.*—Nickel thickness specified depends upon the base metal and whether tank or barrel plated. It is the same for all grades of polishing.

3. *Type of Plated Deposit (Process Specification)*

The plating process specified for any part depends on the nature of the desired finish. For example, one process is used where a nickel deposit is required on both the inside and outside, as in a percolator. Another process gives a heavy layer deposited quickly on parts which are buffed. Another process gives a fairly rapid, heavy deposit where one side is buffed and the other side is not buffed, but still must be bright. Another process is slower but is used for articles which cannot be completely submerged or plated in a conveyor. Another process covers plating in the roto-barrel.

4. *Test of Finished Part (Quality Standard)*

Parts are tested for thickness of plate, and plated steel parts must pass an 8-hour salt spray test, which is carried out in accordance with the Salt Spray Test Process Specification. We are aware that wide variations in results are obtainable in different salt spray cabinets under varying conditions, but for our purpose

the use of the salt spray test under uniform conditions gives satisfactory results.

The process specifications are developed by the thought and study of all members of the Company who are concerned in carrying them out. They are then written down and established as standard practice so that any plating foreman could take charge of the department and produce the result desired. The specifications describe the equipment necessary, the composition and upkeep of the solutions, specifications for purchase of materials, operating conditions, such as temperature, pH, current density, average time required to produce specified thickness of deposit and method of racking, rinsing and drying parts. It also refers to the process specification for the proper cleaning of parts preparatory for plating.

The object of this paper is to call to your attention the necessity and value of standards and standardization. Take this example from the plating industry. In the May, 1929, issue of one of the magazines, there was published a request for standard specifications covering nickel plating. Obviously it was impossible for the editor to comply with the request because who knows what "the standard" is for nickel plating? Every standard has to be in relation to the use for which the thing specified is intended. However, the editor did his best and told the reader the Federal Specifications Board's requirements for thickness of nickel deposited on brass plumbing fixtures.

If your organization, whether large or small, is working on a program of standardization, it is a step forward and should receive your full cooperation. Anything which helps your company helps you. You can even start a plan of standardization in your own department by adopting and writing down standard processes for the operations as carried out, and also by simplifying or reducing the numbers and kinds of various supplies you use. You will be surprised at the number of savings possible by determining what material gives the best results for any particular job and then adhering strictly to the use of that material only.

Much of the subject matter presented in this paper has been gathered from articles and books read on the subject, especially the books "Standards and Standardization," by Norman F. Harriman, and "Industrial Standardization," published by the National Industrial Conference Board, Inc.

ALL ABOARD

ANNUAL MEETING

JUNE 30, JULY 1, 2, 3, 1930

WASHINGTON, D. C.

BALTIMORE-WASHINGTON BRANCH

The regular monthly meeting of the Baltimore-Washington Branch, A. E. S., was held at Branch No. 2 of Enoch Pratt Library, Calhoun and Hollins streets, Baltimore, May 24, 1930.

The meeting was opened at 7 p. m. Dr. Wm. Blum gave a short talk explaining the experiments made at the Bureau of Standards the previous meeting.

The minutes of the last regular meeting were read and approved, after which the president, Matthew J. Kraft, ordered the annual election of officers.

Nominations were made by the nominating committee. The following were duly elected and took office:

Thomas J. Slattery, President; Wilbur S. Ermlich, Vice President; Irvin H. Hahn, Secretary and Treasurer; Dr. Wm. Blum, Librarian. Board of Managers: Matthew J. Kraft, Alvin D. Fewell, Arthur G. Pierdon.

F. F. Pierdon, W. S. Ermlich, T. F. Slatterly were elected delegates

to the Eighteenth Annual Convention. M. J. Kraft, Geo. F. P. Turner and A. D. Fewell as Alternates.

The Convention Committees then made their reports, and after a lengthy discussion, the meeting was closed at 11 o'clock.

IRVIN H. HAHN, Secretary.

HARTFORD-CONNECTICUT VALLEY BRANCH

The Hartford-Connecticut Valley Branch held its regular monthly meeting at the Hartford Chamber of Commerce, 805 Main street, Hartford, Conn., May 26, 1930.

The meeting was called to order at 8:15 with President Beloin in the chair. Minutes of the previous meeting were read and accepted. All communications were read and placed on file. All bills were voted paid. One applicant was elected to active membership, this being Mr. Joseph Holdings of Westfield, Mass. All committees gave their banquet reports and were discharged with a vote of thanks. Our banquet was a big success, even surpassing that of last year. Over two hundred attended the afternoon educational session and approximately that number attended the banquet and entertainment in the evening. This is the first banquet run without the aid of paid advertising by our branch and was a big success from every point of view.

We held our annual election of officers. The members elected are as follows:

President, Mr. Joseph Beloin (re-elected); Vice President, Mr. Edward Fleming (re-elected); Secretary-treasurer, Mr. Vernon E. Grant (re-elected); Librarian, Mr. Wm. Seidel. Board of Managers: Mr. C. R. Prescott, Mr. E. R. MacNicholls, Mr. George Vibberts. Delegates to the National Convention: Mr. W. J. R. Kennedy, Mr. W. T. Jordan, Mr. Joseph Beloin.

Two of our members gave talks on the methods of handling their own line of work. The first speaker was Mr. Kennedy, who gave some very interesting facts about rust prevention on steel and iron parts. His talk was interesting and appreciated by the members present.

Our second speaker was Mr. MacFayden, who gave a very interesting talk on lacquer and enamel finishes. He brought some very beautiful finished samples of the work which made his talk very interesting as well as instructive. Both speakers were given rising votes of thanks.

Our speaking for the June meeting will be Mr. C. R. Prescott, of the New Haven Sheradiging Co.

The meeting was attended by twenty-six members and was adjourned at 10:30 p. m.

V. E. GRANT, Secretary.

DETROIT BRANCH

Detroit Branch held its regular monthly meeting Friday evening, June 6, at the Statler Hotel. President B. F. Lewis presiding. After the regular order of business the nomination and election of officers for the coming year took place. The following were elected:

President, Jos. H. Hansjosten; Vice President, B. F. Lewis; Secretary-Treasurer, C. M. Phillips; Board of Managers: Wm. McCord, Percy Stapleton, George Kutzen; Librarian, H. J. Jameson.

CHAS. M. PHILLIPS, Sec.-Treas.

NEWARK BRANCH

The Newark Branch held its regular monthly open meeting on May 16, 1930, at 41 Franklin street, Newark, N. J., Vice President Colabrese presiding, due to the illness of President De Votie. There were 104 members present.

Vice President called the meeting to order at 8:15 p. m., New York being very well represented.

Motion made and seconded that the branch dispense with the regular order of business.

Vice President turned the meeting over to the Educational Secretary, Mr. Paul Oldam.

Mr. Leredsen, the first speaker, was introduced and passed around samples of work cyanide copper plating.

Mr. Paul Oldam then called upon the principal speaker of the evening, Dr. L. C. Pan of the New York City College and a member of New York Branch, A. E. S. Dr. Pan's subject for the evening was the throwing power of cyanide copper solutions. Dr. Pan's talk was indeed good and created more than usual interest throughout the splendidly prepared talk. The cavity scale was used by Dr. Pan for determniing the throwing power. The first was a solution containing 20.1 cuCN.—25.8 naCN. to find the throwing power of sodium carbonate using from 5 grams to 150 grams per litre and on the cavity scale No. 288.

Next sodium thiosulphate or Hypo. was used and up to one-half gram per litre and on the cavity scale was No. 370 though at one-half gram per litre brown spots began to appear in the copper deposit.

Caustic was next and read on the cavity scale No. 420.

Sodium chloride was next used and read No. 180 on the cavity scale.

Dr. Pan was given a rising vote of thanks. Refreshments were then in order and the spirit of brotherly love prevailed.

On June 7, 1930, the Newark Branch held its first regular meeting of the new fiscal year. The following officers were elected and installed by Supreme President Horace H. Smith:

Mr. A. Calabrese, President; Mr. W. Harrison, Vice President; Mr. G. Reuter, Secretary-Treasurer; Mr. P. Oldam, Educational Secretary; Mr. W. Baurer, Sergeant-at-Arms; Mr. W. Di Votie, Mr. Glichenhaus, Mr. Wagner, Trustees.

The following applications were received: Mr. Lionel M. DeWaltoff, Mr. William Bloets, Mr. William Hodecker.

The following were elected to membership of the A. E. S., Newark Branch: Mr. William Tuttle, Mr. Charles Whitehead, Mr. Bert Sage, Mr. Charles W. Neild.

Thanking you for past favors, I remain,

Yours very truly,

GUY REUTER, Sec., Newark Branch, A. E. S.

CHICAGO BRANCH

The 219th regular meeting of Chicago Branch A. E. S. was held Saturday, June 14, 1930 at Atlantic Hotel. Meeting was called to order with President S. J. C. Trapp presiding.

After the usual business of the Branch had been transacted, President Trapp appointed Past President O. E. Servis and Frank Hanlon to conduct the installation of the officers for the ensuing year.

Mr. Servis appointed Gus Jelinek and Fred Herbst to assist as marshalls and the following officers were duly installed: S. J. C. Trapp, President; J. J. Witte, Vice President; J. C. Kretschma, Secretary-Treasurer.

Past President F. Hanlon assisted by P. P. S. Huenerfauth and R. Meyers, installed Mr. O. E. Servis as Librarian, and board of managers, consisting of R. J. Hazucha, chairman; Gus Jelinek and F. Herbst.

Mr. R. J. Hazucha had the pleasure of installing Mr. D. Greenblatt Sergeant-at-Arms.

The meeting was then turned over to the Librarian who found but three questions in the box. The attendance was good but it was very warm which probably accounts for the lack of questions.

Question No. 1. Can a chromium sol. sulphate content be successfully maintained with zinc sulphate? If so, will zinc plate out?

Answer No. 1. Zinc sulphate can be used. Zinc will not plate out, but why add an impurity when the same thing can be done with sulphuric acid.

Question No. 2. What is the best method for removing oxides from metal containing 85 per cent copper, 5 per cent tin, 5 per cent lead, 5 per cent zinc, so that a good nickel adherence can be had for a 15 minute chrome plate?

Answer No. 2. Pickle in hot muriatic acid, then bright dip and clean in the usual way.

Question No. 3. Would the use of a lead anode in a nickel sol. have any effect in the sol.?

Answer No. 3. Not a practical method, the sol. will eventually plate dark and the ph. would be hard to control. The cost of the nickel salts that would have to be added would be prohibitive.

Members please note.—It was suggested that the secretary be notified of any positions that may be open.

J. C. KRETSCHMER, Sec'y.

APPLICATIONS

	Branch
Chas. N. Rink, 4928 N. Mansfield Ave.	Chicago
Thomas Baker, 144 Earlsdown Ave., New Coventry, England.	Philadelphia
Lambert H. Stantcup, 1416 Lenox Ave., Philadelphia, Pa.	Philadelphia

ELECTIONS

	Branch
Chas. F. Meidig	Philadelphia
Chas. Muss, 4056 N. 7th St., Philadelphia, Pa.	Philadelphia
W. N. Wentz, 5300 Van Ness Ave., Los Angeles, Cal.	Los Angeles
Louis A. Delamotte, 517 18th St., Oakland, Cal.	Los Angeles
Robert Lewis, 1100 W. 73rd St., Los Angeles, Cal.	Los Angeles
Walter Hestrup, R. 1, Box 1120, Downey, Cal.	Los Angeles
G. A. Williams, 4921 Lincoln Ave., Los Angeles, Cal.	Los Angeles
LeRoy E. Watt, 528 E. 15th St., Los Angeles, Cal.	Los Angeles
J. F. Fleckenstein, P. O. Box 941, Los Angeles, Cal.	Los Angeles
H. G. Rice, 290 Hillside Ave., Waterbury, Conn.	Bridgeport
John Brown, 140 Hope St., Stamford, Conn.	Bridgeport
Chas. M. Altermatt, East Main St., Branford, Conn.	Bridgeport
Pasquale Pempeuella, 99 Clinton Ave., Stamford, Conn.	Bridgeport
Wm. J. Peters, % Stanley Chem. Co., Stamford, Conn.	Bridgeport
Wm. E. Stadel, 415 Oakdale St., S. E., Grand Rapids, Mich.	Grand Rapids
Chas. Dougherty, 8397-A Berre St., Montreal, Canada	Montreal
Jos. Holzinger, 84 George St., Westfield, Mass.	Hart-Con Valley
Karl G. Soderberg, % Udylite Process Co., 3220 Bellevue Ave., Detroit, Mich.	Detroit
Mathew Lang, % United Chrom. Corp., 3220 Bellevue Ave., Detroit, Mich.	Detroit
Geo. Swarbick, 11738 Yellowstone, Detroit, Mich.	Detroit
P. J. Irbacker, 4101 W. 25th St., Chicago, Ill.	Chicago
A. S. Arcuri, 4913 Cortes St., Chicago, Ill.	Chicago
Arthur Willink, Frankford Arsenal, Philadelphia, Pa.	Philadelphia
John L. Roberts, Jr., Manheim Apts. B-1, Queen Lane, Germantown, Pa.	Philadelphia
A. Bosley, 6 Rosary Rd., Erdington, Bermingham, Eng.	Philadelphia

RESIGNED

	Branch
Joseph Dinan	Philadelphia

TRANSFERS

	Branch
Geo. Knecht to Bridgeport from	Philadelphia

SUSPENSIONS

	Branch
Nelson A. Bernard, 87 Congress Ave., Providence, R. I.	Bridgeport

BALTIMORE-WASHINGTON

Meets in Enoch Pratt Library, Calhoun and Hollins Sts. Geo. F. Turner, Secretary, 5324 Maple Ave., Pimlico, Baltimore, Md.

BOSTON

Meets at American House, Boston, Mass. First Thursday each month. Secretary Thos. Johnson, 41 first St., South Boston, Mass.

BRIDGEPORT

Meets first and third Friday of each month at Chamber of Commerce Rooms, Stratfield Hotel. Secretary. Wm. Ehrencrona, Box 301, R. F. D. No. 1., Bridgeport, Conn.

CHICAGO

Meets second Saturday of each month, at 8 p. m., Atlantic Hotel, 316 S. Clark St. Secretary, J. C. Kretschmer, 1914 Warner Ave.

CINCINNATI

Meets every Thursday, 7:30 p. m., at Vocational Training School, Spring and Liberty St. Secretary, Al. Yeager, 2021 Sherman Ave., Norwood, Ohio.

CLEVELAND

Meets first Saturday of each month at Hotel Winton. H. Terdoest, 380 Pioneer Ave., Akron, Ohio.

HARTFORD-CONN. VALLEY

Meets fourth Monday in each month alternately at 266 Pearl St., Hartford, Conn., and corner Broadway and Worthington St., Springfield. Secretary, Vernon Grant, 43 Putnam St., Bristol, Conn.

DAYTON

Meets first Saturday of each month at the Y. M. C. A., Dayton, Ohio. Secretary, Robert G. Suman, 2734 Ridge Road, Dayton, Ohio.

DETROIT

Meets the first Friday of each month at the Hotel Statler, Louis II Room, Detroit. Secretary, Chas. Phillips, 13421 Camden Ave., Detroit, Mich.

GRAND RAPIDS

Meets on the second Friday of each month at 528 Lake Michigan Drive, N. W. Secretary, Jacob Van Dyke, 1361 Union Ave., N. E., Grand Rapids, Mich.

INDIANAPOLIS

Meets the second Saturday of each month at Hotel Denison. Secretary, Louis Mertz, 1725 Union St., Indianapolis, Ind.

LOS ANGELES

Meets second Wednesday of each month at the Elite, 633 E. Flower St., Los Angeles, Calif. Secretary, M. D. Rynkofs, 1354 W. 25th St., Los Angeles, Calif.

MILWAUKEE

Meets second and fourth Thursdays of each month at Cor. 3rd St. and Highland Ave. J. N. Hock, 1229 W. 24th St., Milwaukee, Wis.

MONTREAL

Meets last Friday of month at Office of Secretary, John H. Feelay, 411 Aylmer St., Montreal, Quebec, Canada.

NEWARK

Meets first and third Fridays of each month at Franklin Hall, 41 Franklin St., Newark, N. J., at 8 p. m. Secretary-Treasurer, Geo. Rueter, P. O. Box 201, Newark, N. J.

NEW YORK

Meets every second and fourth Fridays of each month in the World Building, Park Row, New York City, N. Y. Secretary-Treasurer, J. E. Sterling, 2581 46th St., Astoria, L. I.

PHILADELPHIA

Meets first Friday of each month in the Harrison Laboratory Building, University of Pennsylvania, 34th and Spruce Sts. Secretary, P. Uhl, 2432 North 29th St., Philadelphia, Pa.

PITTSBURGH

Meets first Friday of each month at 8 p. m., at downtown branch, Y. M. C. A. Secretary, S. E. Hedden, 227 Fifth St., Aspinwall, Pa.

PROVIDENCE-ATTLEBORO

Meets first and third Thursday of each month at 44 Washington St., Prov. Engineers Rooms, Providence, R. I. Secretary, J. H. Andrews, 19 Rosedale St., Providence, R. I.

ROCHESTER

Meets every third Friday of each month at the Powers Hotel. Secretary, Chas. Griffin, 24 Garson Ave., Rochester, N. Y.

ST. LOUIS

Meets second Friday of each month at Central Y. M. C. A., 16th and Locust St. Secretary, C. T. McGinley, 8214 Fairham Ave., University City, Mo.

TOLEDO

Meets first Thursday of each month at Toledo Secor Hotel, corner Cherry and Page Sts. Secretary, L. D. Cope, 3747 Grantley Rd., Toledo, O.

TORONTO

Meets fourth Monday of each month at Canadian Foresters' Hall, 22 College St., Room No. 2. Secretary, H. W. Graham, 102 Robina Ave., Toronto, Canada.

WATERBURY

Meets the second Friday of the month at Engineers Hall, No. 11 East Main Street. Wm. F. Guilfoile, secretary, P. O. Box 961, Waterbury, Conn.

WORCESTER

Meets Directors' Room, Chamber of Commerce, Worcester, Mass. Roger H. Bryant, Secretary, 94 Grove St., Worcester, Mass.